If any further fees are required in connection with the filing of this Amendment, please charge such fees to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: 1/24/02

By: [signature]
Paul I. Kravetz
Registration No. 35,230

700 Eleventh Street, NW, Suite 500
Washington, D.C. 20001
(202) 434-1500

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

At page 1, before line 1, please insert:

--TITLE OF THE INVENTION--

At page 1, line 2, please insert:

--BACKGROUND OF THE INVENTION--

At page 1, line 3, please insert:

--1. Field of the Invention--

At page 1, after line 4, please insert:

--2. Description of the Related Art--

At page 5, after line 29, please insert:

--SUMMARY OF THE INVENTION--

Please REPLACE the paragraph beginning at page 7, line 14, with the following:

--BRIEF DESCRIPTION OF THE DRAWINGS--

At page 9, after line 14, please insert:

--DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS--

At page 21, please delete line 1, in it's entirety, and insert:

--WHAT IS CLAIMED IS:--

IN THE CLAIMS:

Please AMEND the claims as follows. For the Examiner's convenience, all claims are set forth below.

1. (ONE AMENDED) An optical network comprising:

a plurality of optical network units; and

an optical source [means] connected and arranged to transmit light signals to each of said plurality of optical network units;

wherein [the] said optical source [means are] is capable of transmitting light signals at one or more of a plurality of different wavelengths, [at least one] each optical network unit [being operable] is preconfigured to accept [more than one] a predetermined different subset of [the] said wavelengths, and each wavelength of [the] said plurality [being] is accepted by [at least one of the said optical network units such that each such wavelength is accepted by] a predetermined different subset of optical network units,

the optical network further comprising:

control [means] circuitry operable to cause [the] said optical source [means] to transmit light signals at one or more selected such wavelengths corresponding to respective desired subsets of [the] said optical network units and further operable to effect a requested bandwidth redistribution by changing said one or more wavelengths selected for transmission to one or more different wavelengths corresponding to one or more different desired subsets of optical network units.

2. (ONCE AMENDED) An optical network as claimed in claim 1, wherein [the] said control [means are] circuitry is operable to cause [the] said optical source [means] to transmit light signals at two or more selected wavelengths corresponding to two or more desired subsets of [the] said optical network units.

3. (ONCE AMENDED) An optical network as claimed in claim 2, wherein [the] said two or more desired subsets together include all of [the] said optical network units.

4. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1, wherein each of [the] said optical network units is operable to accept more than one of [the] said plurality of wavelengths transmitted by the optical source [means].

5. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1, wherein the optical source [means] comprises a plurality of fixed wavelength lasers, each laser being operable to transmit at one of [the] said plurality of wavelengths.

6. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1, wherein the optical source [means] comprises one or more tunable lasers.

7. (NOT AMENDED) An optical network as claimed in claim 6, wherein the number of tunable lasers is equal to the number of desired subsets of optical network units.

8. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1, wherein at least one of the optical network units comprises a filter, which passes only those wavelengths that are to be accepted by that optical network unit, and a receiver, which responds to light energy which is passed by the filter.

9. (NOT AMENDED) An optical network as claimed in claim 8, wherein said filter comprises a fixed filter.

10. (NOT AMENDED) An optical network as claimed in claim 8, wherein said filter comprises a Fabry-Perot filter.

11. (NOT AMENDED) An optical network as claimed in claim 8, wherein said filter comprises a tunable filter.

12. (NOT AMENDED) An optical network as claimed in claim 8, wherein said filter comprises a wavelength division demultiplexer which splits the incoming signal into various wavelengths, and wherein only those wavelengths which are to be passed by the filter are connected to the receiver.

13. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1, wherein, in the case of two or more desired subsets, a particular optical network unit is not included in more than one of the two or more desired subsets of [the] said optical network units.

14. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1, wherein the network is a passive optical network.

15. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1, wherein signals transmitted from the optical source [means] to an optical network unit are carried by optical [fibres] fibers.

16. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1 as applied to an optical ring architecture.

17. (ONCE AMENDED) An optical network as claimed in [any one of] claim[s] 1 [to 15], as applied to a bus architecture.

18. (ONCE AMENDED) An optical network as claimed in [any preceding] claim 1, wherein the optical source [means] is located within one of the optical network units.

19. (ONCE AMENDED) Control circuitry for use in an optical network, which network comprises a plurality of optical network units and an optical source [means] connected and arranged to transmit light signals to each of said plurality of optical network units, said optical source [means] being capable of transmitting light signals at one or more of a plurality of different wavelengths, [at least one] each optical network unit being [operable] pre-configured to accept [more than one] a predetermined different subset of [the] said wavelengths, and each wavelength of [the] said plurality being accepted by [at least one of the said optical network units such that each such wavelength is accepted by] a predetermined different subset of optical network units,

the control circuitry being operable to cause [the] said optical source [means] to transmit light signals at one or more selected such wavelengths corresponding to respective desired subsets of [the] said optical network units and further being operable to effect a requested bandwidth redistribution by changing said one or more wavelengths selected for transmission to one or more different wavelengths corresponding to one or more different desired subsets of optical network units.

20. (ONCE AMENDED) Control circuitry as claimed in claim 19 which is operable to cause [the] said optical source [means] to transmit light signals at two or more selected wavelengths corresponding to two or more desired subsets of [the] said optical network units.

21. (ONCE AMENDED) Control circuitry as claimed in claim 20, wherein [the] said two or more desired subsets together include all of [the] said optical network units.

22. (ONCE AMENDED) Control circuitry as claimed in [any one of] claim[s] 19 [to 21], wherein, in the case of two or more desired subsets, a particular optical network unit is not included in more than one of the two or more desired subsets of [the] said optical network units.

23. (ONCE AMENDED) A dynamic bandwidth assignment method for an optical network comprising [optical source means capable of transmitting light signals at one or more of a plurality of different wavelengths, each of the said wavelengths being accepted by a different subset of optical network units of the said network] <u>a plurality of optical network units and an optical source connected and arranged to transmit light signals to each of said plurality of optical network units, said optical source being capable of transmitting light signals at one or more of a plurality of different wavelengths, each optical network unit being pre-configured to accept a predetermined different subset of said wavelengths, and each wavelength of said plurality being accepted by a predetermined different subset of optical network units</u>, in which method:

light signals are transmitted by [the] said optical source [means] at one or more wavelengths, selected from [the] said plurality of wavelengths, corresponding to one or more desired subsets of optical network units, and,

in response to a required bandwidth redistribution, [the] said one or more wavelengths at which light signals are transmitted by [the] said optical source [means] are changed to one or more different wavelengths, selected from [the] said plurality, which correspond to one or more different desired subsets of optical network units.

24. (ONCE AMENDED) A method as claimed in claim 23, wherein light signals are transmitted by [the] said optical source [means] at two or more wavelengths, selected from [the] said plurality of wavelengths, corresponding to two or more desired subsets of optical network units.

25. (ONCE AMENDED) A method as claimed in claim 24, wherein [the] said two or more desired subsets together include all of [the] said plurality of optical network units.

26. (ONCE AMENDED) A method as claimed in [any one of] claim[s] 23 [to 25], wherein, in the case of two or more desired subsets, a particular optical network unit is not included in more than one of the two or more desired subsets.

Please ADD the following new claim:

27. (NEW) An optical network comprising:

a plurality of optical network units; and

optical source means connected and arranged to transmit light signals to each of said plurality of optical network units;

wherein said optical source means are capable of transmitting light signals at one or more of a plurality of different wavelengths, each optical network unit is pre-configured to accept a predetermined different subset of said wavelengths, and each wavelength of said plurality is accepted by a predetermined different subset of optical network units,

the optical network further comprising:

control means operable to cause said optical source means to transmit light signals at one or more selected such wavelengths corresponding to respective desired subsets of said optical network units and further operable to effect a requested bandwidth redistribution by changing said one or more wavelengths selected for transmission to one or more different wavelengths corresponding to one or more different desired subsets of optical network units.

Docket No.: 1267.1024

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Peter Raymond BALL, et al.

Serial No. 09/914,575 | Group Art Unit: Unassigned

Confirmation No. 9631

Filed: August 31, 2001 | Examiner: Unassigned

For: OPTICAL NETWORKS

MARKED-UP COPY OF THE
AMENDED PAGES OF THE SPECIFICATION

2. Description of the Related Art

TITLE OF THE INVENTION

OPTICAL NETWORKS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to optical networks.

Figure 1A of the accompanying drawings shows in block diagram form the basic components of a passive optical network (PON). A multiwavelength optical source 3, located in a central office 1, transmits light signals consisting of multiple discrete wavelengths $\lambda_1 \ldots \lambda_N$ down an optical fibre 10 to a wavelength division multiplexer (WDM) 7, located in a remote node 5, which then distributes the signals to a set of optical network units (ONUs) 9, via separate fibres 11. The network is described as passive since the optical routing components (such as the WDM 7) cannot actively be controlled or tuned during their operational use.

The wavelength division multiplexer 7 may be one of a variety of types. An example of a simple multiplexer is a power-splitting star coupler which simply splits incoming light into all ports equally; it is the trivial case of wavelength division multiplexing, because no selection is made on the basis of wavelength, and consequently all wavelengths $\lambda_1 \ldots \lambda_N$ are distributed to all ONUs 9, as illustrated in Figure 1B of the accompanying drawings. This arrangement is sometimes referred to as "broadcast-and-select", since each signal is broadcast to multiple ONUs 9, and each ONU 9 then selects only those signals intended for it.

Instead of such a power-splitting star coupler, a wavelength routing element, for example an arrayed waveguide grating (AWG), could be used. An AWG splits incoming light into spectral constituents, launching them onto separate output fibres. In this way, with an appropriately-designed AWG, incoming light consisting

above. Thirdly, the system would be more robust; if the tuning is at the ONU 9 then either an acknowledgement of successful retuning is required, resulting in further delay, or there is the risk of an error in retuning resulting in the loss of cells transmitted to the ONU 9 on the new wavelength. Fourthly, the more expensive, tunable components would be placed at the head end, where only a few are required, rather than providing expensive tunable systems at each ONU; this would lead to a cost reduction.

There are still certain drawbacks, however, to such a fixed-filter, tunable-laser approach. Firstly, cells could be addressed to more than one ONU 9. This means that bandwidth would be wasted when the network transmits broadcast or multicast traffic, because the cell needs to be replicated and retransmitted on the wavelength of each destination ONU 9. In contrast, a system with tunable filters at the ONU could be configured so that all the ONUs 9 in a multicast group can be tuned to the same channel. Secondly, constant retuning of the lasers at the head end would be required. Consequently, if the tuning time is non-negligible, then a loss of bandwidth would result.

It is therefore desirable to provide a multiwavelength, broadcast-and-select optical network which combines head end tuning with efficient transmission of broadcast and multicast traffic.

X

According to an embodiment of a first aspect of the present invention there is provided an optical network comprising: a plurality of optical network units; and optical source means connected and arranged to transmit light signals to each of said plurality of optical network units; wherein the said optical source means are capable of transmitting light signals at one or more of a plurality of different wavelengths, at

SUMMARY OF THE INVENTION

BRIEF DESCRIPTION OF THE DRAWINGS

being accepted by a different subset of optical network units of the said network, in which method: light signals are transmitted by the said optical source means at one or more wavelengths, selected from the said plurality of wavelengths, corresponding to one or more desired subsets of optical network units, and, in response to a required bandwidth redistribution, the said one or more wavelengths at which light signals are transmitted by the said optical source means are changed to one or more different wavelengths, selected from the said plurality, which correspond to one or more different desired subsets of optical network units.

XX X ~~Reference will now be made, by way of example, to the accompanying drawings, in which:~~

Figure 1A shows in block diagram form the basic components of a multiwavelength passive optical network;

Figure 1B shows the passive optical network of figure 1A employing a power-splitting star coupler;

Figure 1C shows the passive optical network of figure 1A employing an arrayed waveguide grating;

Figure 2 shows in block diagram form the basic components of a two-stage passive optical network;

Figure 3 shows the basic principle of a staggered filter optical network architecture embodying the present invention;

Figure 4 shows the passband of the filter in each optical network unit of Figure 3;

Figure 5 shows the Figure 3 optical network architecture when the load is unbalanced;

Figure 6 shows the optical network units served by each laser of the Figure 3 embodiment for various laser tunings;

Figure 7 shows the optical network units served by each laser in another embodiment of the present

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

bandwidth in an embodiment of the present invention;

Figure 22 is another graph showing estimated savings of bandwidth in an embodiment of the present invention;

Figure 23 shows an embodiment of the present invention applied to a ring network architecture;

Figure 24 shows an embodiment of the present invention applied to a bus network architecture;

Figure 25 shows an example of a unidirectional optical coupler for use in the Figure 23 and Figure 24 embodiments; and

Figures 26 and 27 show possible designs of a bidirectional optical coupler for use in the Figure 23 and Figure 24 embodiments.

Figure 3 shows the basic principle of a staggered filter optical network architecture embodying the present invention. In this embodiment, there are two tunable lasers 3 capable of transmitting a total of 10 wavelengths λ_1 to λ_{10} to a total of eight optical network units 19, ONU_1 to ONU_8. The first tunable laser 3 is capable of transmitting one of five wavelengths λ_1 to λ_5, and in the present example is tuned to λ_3. The second tunable laser is capable of transmitting one of five wavelengths λ_6 to λ_{10}, and in the present example is tuned to λ_8. Control portion 18 is in communication with, and controls the operation of, the tunable lasers 3.

Each optical network unit 19 employs a bandpass filter which allows a group of five consecutive transmitted wavelengths to be passed. For example, as indicated in Figure 3, ONU_1 passes wavelengths λ_1 to λ_5, while ONU_4 passes wavelengths λ_3 to λ_7. The table of Figure 4 summarises the passband of the filters in each of the ONUs 19, where shaded boxes indicate those wavelengths that are passed by the appropriate filter. It can be seen that, in this embodiment, the passband